Projects for Simulation of California's Climate: Draft Protocols

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Welcome/Logistics

- Welcome to beautiful ~~downtown~~ Sacramento.
- Invited speakers: Please give travel receipts to Sharon Mickels *this morning* (or mail them in later).

Why are we here?

The CEC wants to fund 2 projects:

1. An intercomparison of high-resolution simulations* of present climate in California;
2. Probabilistic projections of future climate.

We need your help in designing these projects.

* Includes statistical downscaling

Why do we need another model intercomparison project?

Several factors make California's climate unique:

- Strong influence of topography;
- Strong spatial gradients in climate;
- Snow-dominated watersheds;
- Wet winters; dry summers;
- Strong influence of El Nino;
- Etc.

Conclusions derived elsewhere about which models etc. are best may not apply in California.

Project Goals: Present-climate intercomparison

- Evaluate high-resolution simulations of present climate in California;
- Give researchers feedback on performance of their models;
- Learn how to improve simulations of Ca, e.g:
  - What are sensitivities to resolutions in driving and nested models?
  - What is sensitivity to a more thorough exploration of model parameter values?
  - Does spectral nudging help?
  - How sensitive is simulated climate to treatment of land surface processes?
  - Etc.

Project Goals: Projections of future climate

- Provide information on California climate change to decision-makers and impacts researchers;
- Produce *probabilistic* projection of future climate in California
  - Quantify uncertainties in forcings and responses;
- Make simulation results, documentation available publicly;
- Coordinate with related projects (e.g. NARCCAP, OURANOS).

Meeting Goals

- Review lessons learned from related projects (e.g. AMIP, PRUDENCE);
- Plan coordination with ongoing related projects (e.g. NARCCAP, OURANOS);
- Get feedback on draft project protocols;
- Have fun talking about science.

Agenda/Eye test

8:30	Workshop goals	Philip Duffy, LLNL
8:45	Introduction and Opening Remarks	Guido Franco, CEC
9:00	AMIP: Approach and Lessons Learned	Karl Taylor, PCMDI
9:30	Discussion	
9:45	PRUDENCE: Approach and Lessons Learned	Jens Christensen, DMI
10:15	Discussion	
10:30	Break	
11:00	PIRCS: Approach and Lessons Learned	Bill Gutowski, Iowa State
11:30	Discussion	
11:45	OURANOS activities and plans	Daniel Caya, OURANOS
12:15	Discussion	
12:30	Lunch	
1:30	NARCCAP objectives and plans	Linda Mearns, NCAR
2:00	Discussion	
2:15	Regional climate via Statistical downscaling	Sasha Gershunov, UCSD
2:45	discusssion	
3:00	Break	
3:15	Unresolved issues in draft protocol	Phil Duffy, LLNL
3:45	Discussion	
5:15	Adjourn	

Please help us to stay on schedule.

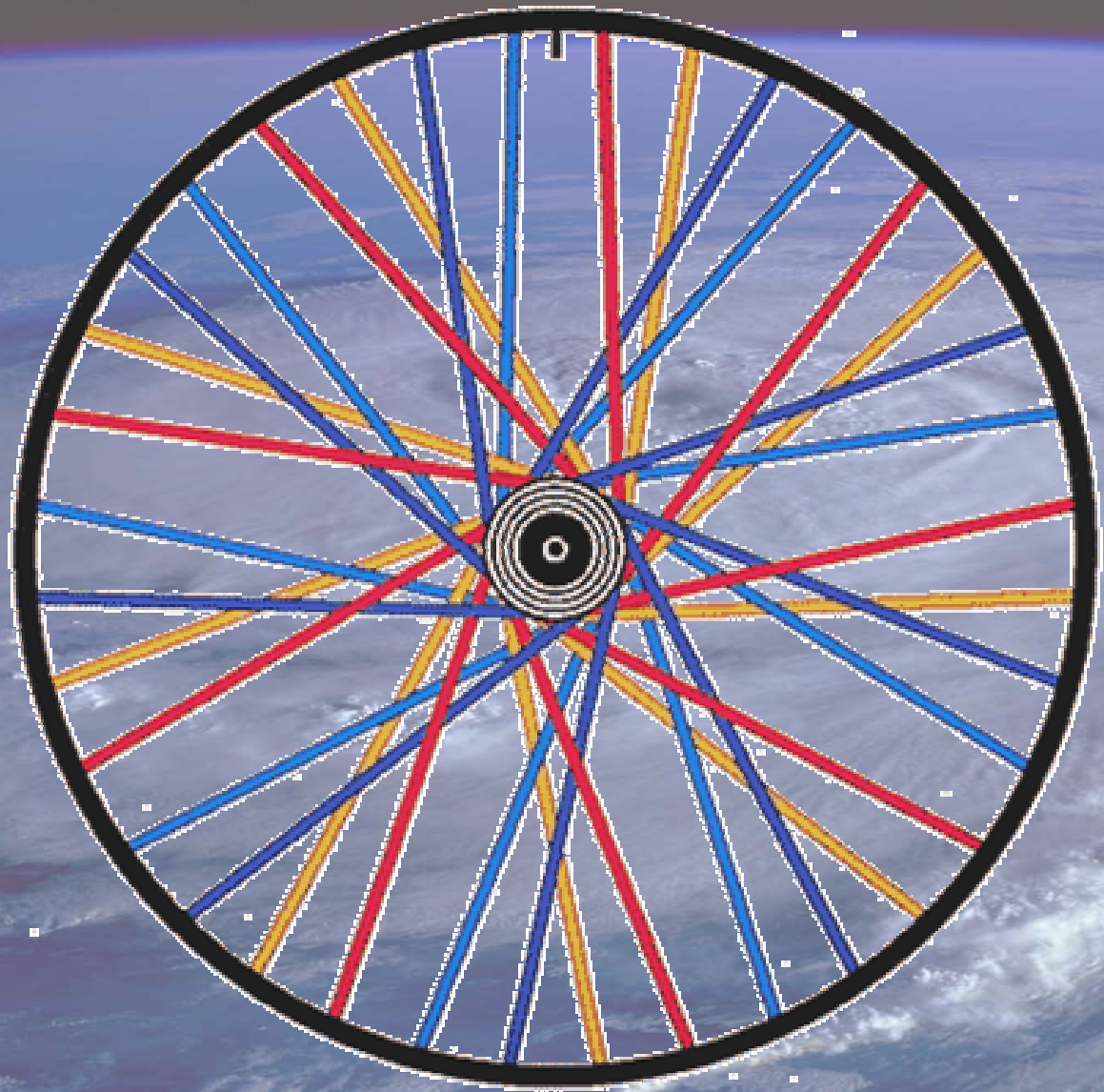
4 Projects

1. Low-Cost Model Intercomparison ($500K)
2. Intermediate-Cost Model Intercomparison ($1M
3. High-Cost Model Intercomparison ($2M)
4. Probabilistic Projections of Future Climate ($2M)

At most, the CEC will fund one of #s 1 - 3, and #4.

Elements common to all projects

Hub and Spoke Structure



Hub responsibilities:

- overall project coordination (e.g. meeting deadlines);
- Interactions w/ sponsor (CEC);
- provide input (e.g. boundary condition) data to spokes;
- Provide (some) computer access for Spokes
- assemble observational data needed for evaluation of results;
- develope/provide metrics and tools for evaluation of results;
- Lead evaluation of simulation results;
- Coordinate peer-reviewed publications and reports;
- provide spokes with tools for performing QC on results, and convert results to common file format;
- assemble documentation on what was done;
- make all results publicly available.

Spokes responsibilties

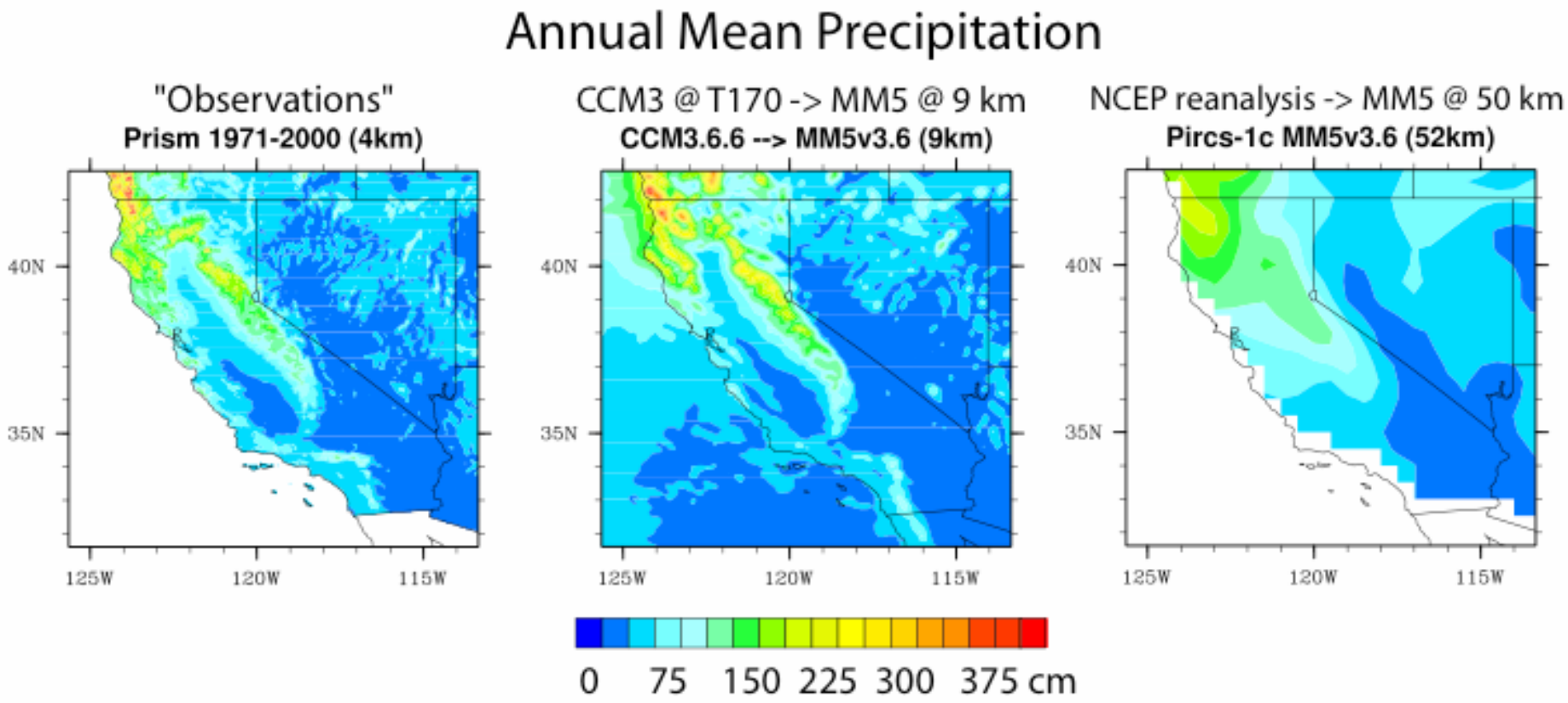
- Provide own computer resources, where possible;
- Perform agreed-upon simulations on time;
- Perform QC on simulation results;
- Convert results to a common file format (using supplied tools);
- Provide documentation on models and results.

Marcel Duchamp, 1913

Hub and Spoke…

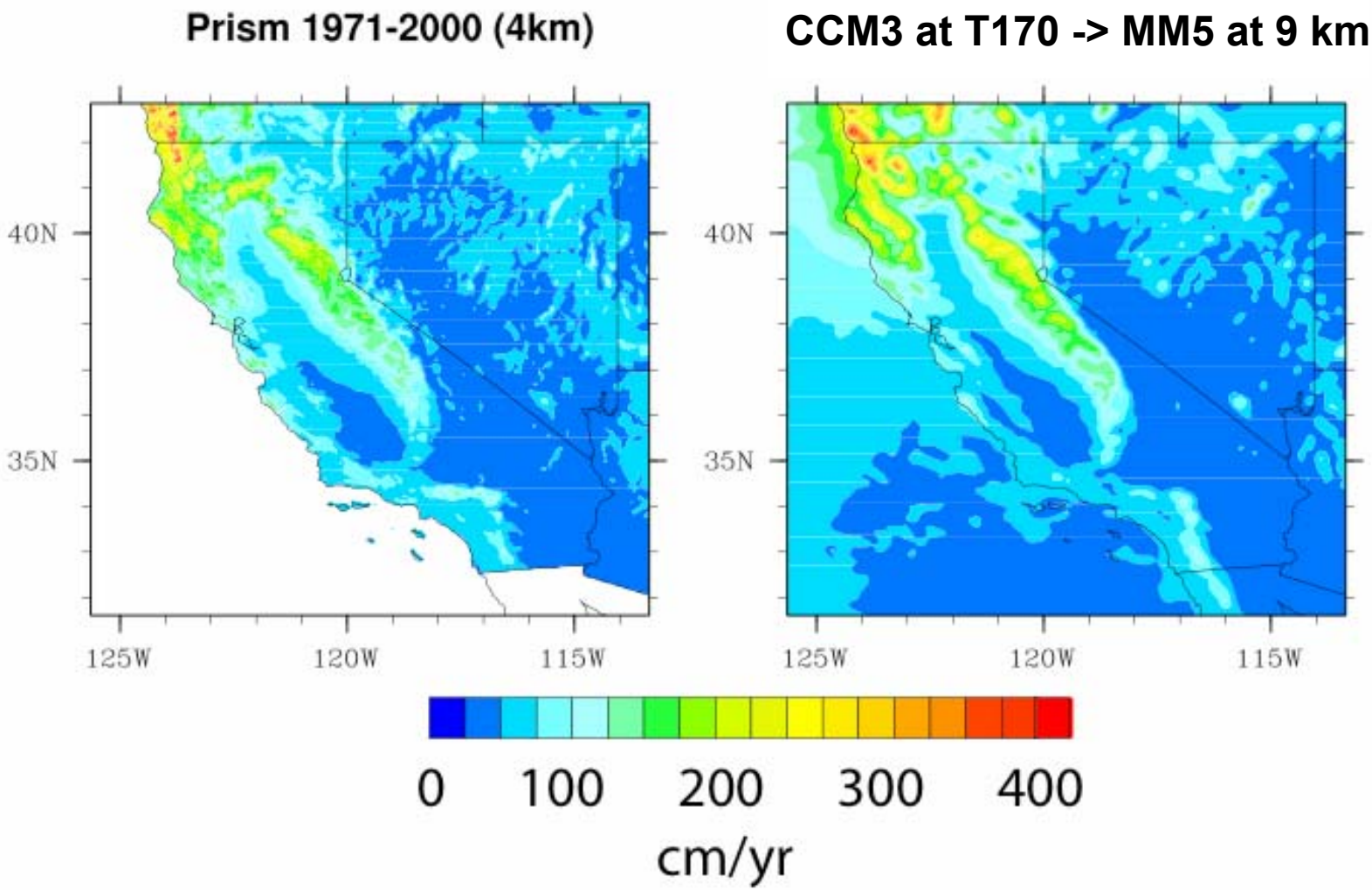
- Hub contractor will be selected by CEC;
- Spoke contractors will be selected by Hub, with final approval from CEC;
- Spoke groups willing to participate *gratis* will be welcomed;
- CEC desires spatial resolution of 10 km in downscaling simulations;
  - Needed to simulate snow, etc.

Why use 10 km resolution?



Why use 10 km resolution?

Annual Mean Precipitation



Options for Inter-project Coordination

1. Compare results “when we’re done;”
2. Use common scenarios and GCMs as basis for downscaling;
3. OURANOS and NARCCAP simulate N. America at ~50 km resolution, and we downscale that.
4. All projects could use planned 50 km global time slice simulations as basis for downscaling.
   - This method was used in PRUDENCE.

1. Low-Cost Model Intercomparison Project

- Minimum budget: $500K
- Downscale reanalysis
  - We suggest ERA 40 because of relatively high resolution (T159; ~125 km).
  - This allows one-step downscaling to ~10 km
- No downscaling of GCMs;
- No simulation of future climate.
- >= 3 Spoke groups.
- Spoke groups not paid to do downscaling, but computer time provided.

Alternatives we don't like:

1. Downscale coarse-resolution reanalysis:
   - difference in grid sizes (250 km vs 10 km) probably too great.
2. Downscale a regional reanalysis:
   - SIO regional reanalysis doesn't need to be downscaled;
   - Have these been thoroughly evaluated?
   - Resolution is so fine that this may not be good indicator of ability to downscale GCMs.
3. Use "Big Brother" methodology:
   - Evaluating results against reanalysis is problematical because models similar to that used to do reanalysis will tend to look good.

Overall Project Budget

	Year 1	Year 2	Total
Effort at Hub	$104	$168	$272
Effort at all Spokes	$0	$88	$88
Computer access	$40	$40	$80
Data storage	$4		$4
Travel/workshops	$20	$20	$40
Publications		$20	$20
Total	**$168**	**$335**	**$503**

Assumed labor costs (include. benefits, overhead, etc):
“senior staff” @ $200K/yr; “technical staff” @ $150K/yr

Year 1 Effort Budget

	Task	Effort level senior staff (mos)	Effort level technical staff (mos)	Est'd Cost (Year 1; $K)
Hub	Prepare and distribute large-scale solution (reanalysis)		2	$25
	Gather observational data for evaluation	0.5	2	$33
	Develop software for conversion of simulation results to common file format		1	$13
	Project coordination; interaction w/ sponsor, etc.	2		$33
Total Hub		2.5	5	$104
Each Spoke	Simulate present climate in CA by downscaling reanalysis	0		$0
Total each Spoke		0	0	$0
Total all Spokes		0	0	0
Total Hub + Spokes		2.5	5	**$104**

Year 2 Effort Budget

	Task	Effort level senior staff (mos)	Effort Level technical staff (mos)	Est'd Cost (Year 2; $K)
Hub	Evaluate downscaling results vs. reanalysis & observations.		6	$75
	Establish project web site.	1.5	1.5	$44
	Preparation of peer-reviewed publication	2	1	$46
	Put downscaling results into standard file format.		0.5	$3
Total Hub		3.5	8.75	$168
Spokes	Preparation of peer-reviewed publication	1	1	$29
Total each spoke		1	1	$29
Total all Spokes		3	3	87.5
Total Hub + Spokes		6.5	11.75	**$255**

Suggestions

Publish a report (in addition to peer-reviewed publications and web site (?)

2. Intermediate-Cost Model Intercomparison Project

Everything in “Low Cost” option, plus:

- Downscaling of 2 GCMs (present climate only)
- Additional analysis of results, e.g.
  - Effects of ENSO;
  - Does downscaling improve large-scale solution?
  - Does spectral nudging improve the downscaled solution?

Downscaling of GCMs

Options:

1. Downscale T85 GCMs to ~30 km;
   - Resolution jump too great?
2. Globally downscale w/ GCM at ~50 km; (LLNL plans to do some of this using DOE funding)
   - then downscale to ~10 km
   - (a la PRUDENCE)
3. Downscale over N. America w/ 50 km RCM
   - Use NARCCAP's results for this.
   - then further downscale in CA region to 10 km.

Truncations vs. grid sizes

Transform grid---------->

Triangular Truncation	# cells EW	#cells NS	Grid size at 40 deg lat (km)	lambda/2 (km) at 40 deg lat
42	128	64	239	365
85	256	128	120	180
106	320	160	96	145
159	478	239	64	96
170	512	256	60	90
239	720	360	43	64

According to B. Denis et al. (2002?), a ratio of grid sizes between driving and nested model = 12:1 is acceptable.

Overall Project Budget

	Year 1	Year 2	Total
Effort at Hub	$150	$342	$492
Effort at all Spokes	$271	$146	$417
Computer access	$35		$35
Data storage	$35		$35
Travel/workshops	$20	$20	$40
Publications		$20	$20
Total	**$203**	**$285**	**$1,038**

Year 1 Effort Budget

	Task	Effort level senior staff (mos)	Effort level technical staff (mos)	Est'd Cost (Year 1; $K)
Hub	Prepare and distribute large-scale solution (reanalysis +2 GCMs)		3	$38
	Gather observational data for evaluation	0.5	2	$33
	Develop software for conversion of simulation results to common file format		1	$13
	Project coordination; interaction w/ sponsor, etc.	4		$67
Total Hub		4.5	6	$150
Each Spoke	Simulate present climate in CA by downscaling reanalysis + 2 GCMs	1	3	$54
Total each Spoke		1	3	$54
Total all spokes		5	15	$271
Total Hub + Spokes		9.5	21	$313

Year 2 Effort Budget

	Task	Effort level senior staff (mos)	Effort Level technical staff (mos)	Est'd Cost (Year 2; $K)
Hub	Evaluate downscaling results vs. observations.	2	12	$183
	Establish project web site.	2	3	$71
	Preparation of peer-reviewed publication	3	2	$75
	Put downscaling results into standard file format.		1	$13
Total Hub		7	18	$342
Spokes	Preparation of peer-reviewed publication	1	1	$29
Total each spoke		1	1	$29
Total all Spokes		5	5	$146
Total Hub + Spokes		12	23	$429

Suggestions

3. High-Cost Model Intercomparison Project

(Can we find a better name?)

Everything in intermediate-cost project, plus evaluate sensitivity to:

- resolution of large-scale fields;
- resolution of RCM;
- different land-surface treatments w/in one RCM;
- improved optimization of model parameter values.

Other possible activities:

- Downscale additional GCMs and/or scenarios;
- More evaluation of effects of El Nino;
- Evaluate simulated daily-timescale variability;
- Statistical vs. dynamical downscaling "bake-off;"
- Expanded web portal.

Overall Project Budget

	Year 1	Year 2	Year 3	Total
Effort at Hub	$221	$479	$225	$925
Effort at all Spokes	$271	$458	$225	$954
Computer access	$35			$35
Data storage	$97		$60	$157
Travel/workshops	$20	$20		$40
Publications		$20		$20
Total	**$203**	**$285**	**$510**	**$2,131**

Year 1 Effort Budget

	Task	Effort level senior staff (mos)	Effort level technical staff (mos)	Est'd Cost (Year 1; $K)
Hub	Prepare and distribute large-scale solution (2 GCMs, 2 scenarios)		4	$50
	Establish project web site	1	1	$29
	Project coordination; interaction w/ sponsor, etc.	3		$50
Total Hub		4	5	$129
Each Spoke	Downscale 4 future climate scanrios (2 GCMs x 2 scenarios)	1	4	$67
Total each Spoke		1	4	$67
Total all spokes		5	20	$333
Total Hub + Spokes		9	25	$329

Year 2 Effort Budget

	Year 2			
	Task	Effort level senior staff (mos)	Effort Level technical staff (mos)	Est'd Cost (Year 2; $K)
Hub	BMA of future climate results	3	12	$200
	Update project web site.	1	3	$54
	Preparation of peer-reviewed publication	4	2	$92
Total Hub		8	17	$346
Spokes	Put downscaling results into standard file format.		2	$25
	Preparation of peer-reviewed publication	1	1	$29
Total each spoke		1	1	$29
Total all Spokes		5	5	$146
Total Hub + Spokes		13	22	$433

Year 3 Effort Budget

	Task	Effort level senior staff (mos)	Effort Level technical staff (mos)	Est'd Cost (Year 2; $K)
Hub	Investigate sensitivitie to RCM parameter values	3	12	$200
	Update project web site.	1	3	$54
	Preparation of peer-reviewed publication	4	2	$92
Total Hub		8	17	$346
Selected Spoke	Investigate sensitivitie to RCM parameter values		2	$25
	Preparation of peer-reviewed publication	1	1	$29
Total selected spoke		1	3	$54
Total Hub + Spokes		9	20	$400

Suggestions

4. Probabilistic Projections of Future Climate

Goals:

- Develop/evaluate methods for quantifying uncertainties
  - Bayesian model averaging
  - Automated parameter exploration
- Produce probabilistic projections of climate change suitable for use by decision-makers, impacts researchers, etc.
- Will *not* address societal impacts, but will provide basis for others to do this.

Possible Research Questions

- Will cold-phase ENSO events (i.e. El Ninos) become more frequent or intense?
- Will frequency of extreme weather events (of various sorts) increase?
- How much snow will go?
- How will potential vegetation change?

Which GCMs/scenarios should be downscaled?

- Use new IPCC simulations.
- Good representation of ENSO important.
- Use low- and high-emission scenarios.
  - E.g. A2 and B1
- Coordinate w/ other projects.

Overall Project Budget

	Year 1	Year 2	Year 3	Total
Effort at Hub	$129	$346	$346	$821
Effort at all Spokes	$333	$146	$254	$733
Computer access	$35			$35
Data storage	$28	$125		$153
Travel/workshops	$20	$20	$20	$60
Publications		$20	$20	$40
Total	**$546**	**$657**	**$640**	**$1,842**

Year 1 Effort Budget

	Task	Effort level senior staff (mos)	Effort level technical staff (mos)	Est'd Cost (Year 1; $K)
Hub	Prepare and distribute large-scale solution (2 GCMs, 2 scenarios)		4	$50
	Establish project web site	1	1	$29
	Project coordination; interaction w/ sponsor, etc.	3		$50
Total Hub		4	5	$129
Each Spoke	Downscale 4 future climate scenarios (2 GCMs x 2 scenarios)	1	4	$67
Total each Spoke		1	4	$67
Total all spokes		5	20	$333
Total Hub + Spokes		9	25	$463

Year 2 Effort Budget

	Year 2			
	Task	Effort level senior staff (mos)	Effort Level technical staff (mos)	Est'd Cost (Year 2; $K)
Hub	BMA of future climate results	3	12	$200
	Update project web site.	1	3	$54
	Preparation of peer-reviewed publication	4	2	$92
Total Hub		8	17	$346
Spokes	Put downscaling results into standard file format.		2	$25
	Preparation of peer-reviewed publication	1	1	$29
Total each spoke		1	1	$29
Total all Spokes		5	5	$146
Total Hub + Spokes		13	22	$492

Year 3 Effort Budget

	Task	Effort level senior staff (mos)	Effort Level technical staff (mos)	Est'd Cost (Year 2; $K)
Hub	Investigate sensitivitie to RCM parameter values	3	12	$200
	Update project web site.	1	3	$54
	Preparation of peer-reviewed publication	4	2	$92
Total Hub		8	17	$346
Selected Spoke	Investigate sensitivitie to RCM parameter values	2	6	$108
Selected Spoke	Develop BMA of multi-model results	2	2	$58
Selected Spokes	Preparation of peer-reviewed publications	3	3	$88
Total selected spokes		7	11	$254
Total Hub + Spokes		15	28	$600

Suggestions

Big Questions

- Should we require common domain?
- Should we use NARCCAP's 50 km simulations as starting point for downscaling?
  - Will there be time to do this?